FCC 96-207

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Advanced Television Systems	)	
and Their Impact Upon the	)	MM Docket No. 87-268
Existing Television Broadcast	)	
Service	)	

FIFTH FURTHER NOTICE OF PROPOSED RULE MAKING

Adopted: May 9, 1996; Released: May 20, 1996

Comment Date: July 11, 1996
Reply Comment Date: August 12, 1996

By the Commission: Chairman Hundt and Commissioners Quello, Ness and Chong issuing separate statements.

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I. Introduction

1. In this proceeding we consider adoption of a digital television ("DTV") broadcast standard. This action has been recommended to the Commission by its Advisory Committee on Advanced Television Service ("Advisory Committee" or "ACATS").[1] We have the following objectives with regard to the authorization and implementation of a DTV standard.[2] We seek to ensure that all affected parties have sufficient confidence and certainty in order to promote the smooth introduction of a free and universally available digital broadcast television service. We seek to increase the availability of new products and services to consumers through the introduction of digital broadcasting. We seek to ensure that our rules encourage technological innovation and competition. And we seek to minimize regulation and assure that any regulations we do adopt remain in effect no longer than necessary.

II. Background

2. On February 13, 1987, 58 broadcast organizations ("Petitioners") filed a joint "Petition for Notice of Inquiry" asking the Commission to initiate a proceeding to explore

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[1] ACATS Report at 19. The Advisory Committee was formed by the Commission on October 16, 1987, pursuant to the Federal Advisory Committee Act (86 Stat. 770, as amended, 5 U.S.C. App. 2 § 1 et seq. (1982 ed. and Supp. V)). It was established "to assist the Commission in considering the issues surrounding the introduction of advanced television service in the United States." (Notice, 52 Fed. Reg. 38523 (October 16, 1987).) The Advisory Committee consisted of a twenty-five member parent committee and three subcommittees -- Planning, Systems and Implementation. Its membership on the date that the ATSC DTV Standard was recommended to the Commission is at Appendix B.

[2] In issuing this Notice, we are requesting comment, inter alia, on whether to accept the conclusions of the Final Report and Recommendation of the Advisory Committee, adopted November 28, 1995 ("ACATS Report"), which recommends the Advanced Television Systems Committee Standard A/53 (1995) ATSC Digital Television Standard ("ATSC DTV Standard") as the standard for DTV broadcasting in the United States. This standard is based on the Advisory Committee design specifications and the Digital HDTV Grand Alliance ("Grand Alliance") System. The ACATS Report is hereby incorporated into the record of this proceeding. Copies of the ACATS Report are available through the Commission's copy contractor, International Transcription Services. Additionally, the ACATS Report, ACATS Final Technical Report and ATSC DTV Standard are available on the Internet at the ATSC site (http://www.atsc.org).

issues arising from the advent of new and advanced television ("ATV") technologies and their possible impact, in either broadcast or non-broadcast uses, on existing television broadcast service. On July 16, 1987, as a result of the comments it received in response to the petition, the Commission inaugurated the instant proceeding, "to consider the technical and public policy issues surrounding the use of advanced television technologies by television broadcast licensees."[3]

3. The Commission empaneled the Advisory Committee on Advanced Television Service (ACATS) shortly after having opened the inquiry phase of this proceeding. Its charter specified, inter alia, that it would recommend "policies, standards and regulations that would facilitate the orderly and timely introduction of advanced television services in the United States." As embodied in the proposed Standard, its work represents 8 years of effort by industry members who designed and developed the digital system. By some estimates, according to ACATS, over one thousand individuals contributed to the work of the Advisory Committee and its subcommittees, working parties, and panels. Among other activities, ACATS designed the detailed testing plans for the system and conducted substantial related studies.

4. The experts assembled by ACATS determined that a "paper" standard would not be sufficient to ensure that a system would work over-the-air as predicted, and therefore decided that candidate systems would have to be reduced to prototype hardware and tested both in laboratories and in actual field tests. To accomplish the testing function, in 1988 the Advanced Television Test Center (ATTC) was established as a private, non-profit organization funded by broadcasting and electronic industry companies. Co-located with the ATTC was the ATV facility of the Cable Laboratories (CableLabs), a consortium of cable television system operators that carried out the cable portions of ACATS' lab and field testing program.

5. In February, 1993, the Advisory Committee reported to the Commission that a digital High Definition Television ("HDTV")[4] system was achievable but that the four competing systems it had tested would each benefit from further development[5] and that none of the systems could, at that time, be recommended over the others. On May 24, 1993 the three groups that had developed the four final DTV systems agreed to produce a single, best-of-the-best system to propose as the standard. The three ventures that joined to become the

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[3] Notice of Inquiry in MM Docket No. 87-268, ("First Inquiry"), 2 FCC Rcd 5125 (1987).

[4] High Definition Television offers approximately twice the vertical and horizontal resolution of NTSC, which is a picture quality approaching 35 millimeter film, and has sound quality approaching that of a compact disc.

[5] ATV System Recommendation of the FCC Advisory Committee on Advanced Television Service (February 24, 1993).

"Grand Alliance" consisted of AT&T and Zenith Electronics Corporation; General Instrument Corporation and Massachusetts Institute of Technology; and Philips Electronics North America Corporation, Thomson Consumer Electronics, and the David Sarnoff Research Center. The standard recommended by ACATS and now before us is based on the system developed, built, and proposed by the Digital HDTV Grand Alliance proposal to ACATS.

6. The members and staff of ATSC[6] considered which elements of the Grand Alliance broadcast system might require action by the Commission and which portions should be voluntary. The ATSC DTV Standard was then drafted by specialist groups divided into five specific areas: video, audio, transport, RF/transmission, and receiver characteristics. A steering committee was established to coordinate the efforts, consisting of the chairs of the five specialist groups, the committee chair and vice-chair, and liaison individuals from the Grand Alliance, ATSC, ACATS, and two FCC senior staff persons.

7. The system described by the ATSC DTV Standard having been successfully designed, built and tested, in November 1995, the Advisory Committee voted to recommend the Commission's adoption of the ATSC DTV Standard. We believe that the ATSC DTV Standard embodies the world's best digital television technology and promises to permit striking improvements to today's television pictures and sound; to permit the provision of additional services and programs; to permit integration of future substantial improvements while maintaining compatibility with initial receivers; and to permit interoperability with computers and other digital equipment associated with the national information initiative. It was developed and tested with the unparalleled cooperation of industry experts and consists of several discrete layers, described more fully in the following section.

III. The ATSC DTV Standard.

8. The description of the ATSC DTV Standard consists of a cover document and five annexes, each of which describes the characteristics of a part of the complete system.[7] The

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[6] "ATSC" is the Advanced Television Systems Committee. ATSC currently has 54 members including television networks, motion picture and television program producers, trade associations, television and other electronic equipment manufacturers and segments of the academic community. It was formed by the member organizations of the Joint Committee on InterSociety Coordination ("JCIC") for the purpose of exploring the need for and, where appropriate, to coordinate development of the documentation of ATV systems. The JCIC is composed of the Electronic Industries Association, the Institute of Electrical and Electronics Engineers, the National Association of Broadcasters, the National Cable Television Association, and the Society of Motion Picture and Television Engineers. The membership of the ATSC when it adopted the ATSC DTV Standard is at Appendix C.

[7] This description of the system documented by the ATSC DTV Standard is partly derived from: Carlo Basile, et. al., "The US HDTV Standard," IEEE Spectrum, Vol. 32,

five components described in the annexes to the ATSC DTV Standard are video coding, audio coding, transport, RF/transmission and receiver. These five basic components, plus a video format selection function, are sometimes referred to as comprising "layers" of the system. The system's flexibility is evident in several ways. Compliance with the ATSC DTV Standard requires some of its provisions be followed, but many of these provisions include numerous acceptable options (for example, see the "format selection" discussion below) that the system's users may select. In addition to the required provisions, some additional provisions of the ATSC DTV Standard are recommended but not required, and others are optional. Finally, although it describes the coding and transmission of television video and audio, it also allows transmission of a variety of other services as "ancillary data." As more fully discussed below, this structure makes the system described by the ATSC DTV Standard extremely flexible and gives it room to incorporate a wide range of future improvements.

9. Format selection: The ATSC DTV Standard supports a variety of scanning formats. Table I shows the number of scanning lines and horizontal picture elements (or pixels) per line, which affect resolution. For reference, our rules for NTSC[8] television broadcasting specify 483 active video lines per frame, with 42 lines in vertical blanking intervals with no video information, for a total of 525 lines. The 720-line and 1080-line formats below represent high resolution video and might be used for motion pictures, other programs captured on film, programs shot with HDTV cameras including sporting events and concerts, and animation and graphics that might be computer-generated. The lower-resolution 480-line formats accommodate existing NTSC programming and equipment as well as material designed for viewing on VGA computer monitors.

Table I

Vertical Lines	Horizontal Pixels	Aspect Ratio	Picture Rate
1080	1920	16:9	60I 30P 24P
720	1280	16:9	60P 30P 24P
480	704	16:9 4:3	60I 60P 30P 24P
480	640	4:3	60I 60P 30P 24P

10. Table I also indicates that the high-resolution formats both use a picture aspect ratio of 16 units horizontally by 9 units vertically (that is, a picture 16 inches wide would be

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No. 4, April 1995, at 36-45. Of the twelve authors that contributed to this, eleven of them were from the companies comprising the Grand Alliance.

[8] NTSC refers to the current analog television system. It is named for the National Television System Committee, an industry group that developed the monochrome (black and white) television standard in 1940-41 and the color television standard in 1950-53.

9 inches tall or one 32 inches wide would be 18 inches tall). The choices of 1280 pixels per line for the 720-line format and 1920 pixels per line for the 1080-line format result in square pixels (that is, pixels which are displayed at equal distances, both horizontally and vertically) for both formats, based on the 16:9 aspect ratio. The 16:9 aspect ratio is noticeably wider than the current NTSC television 4:3 aspect ratio. Material in the 480-line by 704-pixel format could use either a 16:9 or a 4:3 aspect ratio.

11. The picture rates specified in Table I identify the number of images that are sent each second, with an "I" designating interlaced scanning and a "P" designating progressive scanning. Progressive scanning lines are presented in succession from the top of the picture to the bottom, with a complete image sent in each frame as is commonly found in computer displays today. For interlaced scanning, which also is used in NTSC television, odd and even numbered lines of the picture are sent consecutively, as two separate fields. These two fields are superimposed to create one frame, or complete picture, at the receiver. The picture rates can be 24, 30 or 60 fields per second.[9]

12. Accounting for the different aspect ratios and picture rates identified in Table I, there are 18 video scanning formats allowed by the ATSC DTV Standard. An attractive feature of the ATSC DTV Standard is that the appropriate format would be chosen by the broadcaster based upon the specific application for which it is to be used (e.g., airing films, live sports events or reruns of television series). Similarly, the DTV broadcaster would be able to pass through program material it receives from an outside source in any of these formats. The identified scanning formats are those used within the DTV system and most of them relate to existing television production standards. However, material in any other format can be converted into one of the allowed scanning formats. Thus, development of additional video production formats can take place recognizing the scanning formats of the ATSC DTV Standard, but not constrained by them. Similarly, when considering the receiver, most display devices are expected to have a "native" scanning format (which may be one of these system scanning formats) to which the received video signal would be converted.

13. Video coding: For compression of video signals, the ATSC DTV Standard requires conformance with the main profile syntax of the MPEG-2 video standard.[10] Employing this standard, the amount of data needed to represent television pictures is reduced using a variety of tools, including a motion compensated discrete cosine transform (DCT)

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[9] These rates can be the stated integer value, or 1000/1001 times the integer value. An adjustment was made to the NTSC system when color was added and it changed the field rate by this amount, that is from 60 fields per second (Hz) to 59.94 Hz. To ease conversion of NTSC material, the ATSC DTV Standard thus allows the field rates to be 23.976, 29.97, or 59.94 Hz, as well as 24, 30, or 60 Hz.

[10] MPEG-2 is a video compression and transport standard created by the Moving Picture Experts Group of the International Organization for Standardization (ISO).

algorithm and bidirectional-frame (B-frame) prediction. DCT alters the data describing each picture in a way that makes it easier to isolate repetitive portions of a single image. Motion compensation identifies portions of an image that have shifted position from one field to the next, or from one frame to the next. B-frame prediction uses both past and expected future frames as a reference. Each of these tools serves to improve compression efficiency by reducing the total amount of digital information that needs to be transmitted.

14. Audio coding: For compression of audio signals, the ATSC DTV Standard requires conformance with ATSC Doc. A/52, the Digital Audio Compression (AC-3) Standard. The AC-3 perceptual coding system, which was developed by Dolby Labs, can encode a complete main audio service which includes left, center, right, left surround, right surround, and low frequency enhancement channels into a bit stream at a rate of 384 kilobits per second (kbps). Audio service can also include fewer channels (down to single channel, monophonic service) using a lower bit rate. Multiple audio bit-streams may be delivered simultaneously for multiple languages or for services for the visually or hearing impaired. The system also contains features that could allow viewers to control fluctuations in audio level between programs or to select the full dynamic range of the original audio program.

15. Transport: The service multiplex and transport layer of the ATSC DTV Standard is a compatible subset of the MPEG-2 systems standard that describes a means of delivering a digital data stream in fixed-length "packets" of information. Each packet contains only one type of data: video, audio or ancillary. There is no fixed mix of packet types, which further helps provide flexibility. Channel capacity can be dynamically allocated in the transport layer, under the direct control of the broadcaster. The ATSC DTV Standard has been optimized for terrestrial digital television delivery, where channel bandwidth is limited and transmission errors and data loss are likely. Within the transport layer, the packets of video, audio, closed captioning and any other data associated with a single digital television program are combined using a mechanism to ensure that the sound, pictures and closed captioning information can be synchronized at the receiver. Data describing multiple television programs, or unrelated data for other purposes, are also combined in the transport layer.

16. RF/Transmission: The transmission layer of the ATSC DTV Standard uses a vestigial sideband (VSB) technique. Like most other digital modulation methods (including quadrature amplitude modulation, or QAM), the VSB technique involves randomizing the incoming data to spread the energy across the occupied bandwidth or channel. As a result, the digital signals generally appear to be random noise which tends to minimize their interference effect on other services (in this case, particularly NTSC). In the ATSC DTV Standard VSB system, a small pilot carrier is added at the suppressed carrier frequency. The VSB pilot is placed so that it minimizes co-channel interference into the existing NTSC service. The relationship of the pilot carrier frequency to interference to lower adjacent channel NTSC service is discussed in the "interference" section below. The pilot can allow a receiver to acquire and lock onto the VSB signal by providing a known and stable reference.

17. Terrestrial broadcasts of DTV will be exposed to situations that include strong

interfering signals, electromagnetic noise from numerous sources, and configurations of buildings or terrain features that cause multipath interference. For successful reception under these difficult conditions, an 8-level VSB signal is specified and extensive error correction is provided. Taking into account the transport requirements and error correction, the 8-VSB signal carries an effective useful payload of approximately 19.28 megabits per second (Mbps). For more benign environments, like that provided in a cable system, the ATSC DTV Standard includes a 16-level VSB high data rate mode that provides double the capacity of the 8-level VSB terrestrial broadcast mode.

18. Receiver: The ATSC DTV Standard does not specify requirements for a compliant receiver. In essence, the DTV receiver designs are to be based on the specifications of the signal contained in the other portions of the Standard. The receiver reverses the functions of the RF/transmission and transport layers, and, after decompression, generates video and audio suitable for its display.

19. Flexibility. The ATSC DTV Standard provides a method of accommodating a broad range of uses. The packetized transport structure is a critical component in achieving this broad level of flexibility. Each packet of data contains a packet identifier (PID) in the packet header which identifies the particular packet's payload. Some PIDs are specified in the ATSC DTV Standard as reserved for the video, audio and data associated with television programs. DTV receivers recognize these PIDs and use the data in these packets. Within a single DTV broadcast or transmission, up to 256 unique programs (not all necessarily video) can be identified. Scrambled packets can be sent, which allows conditional access subscription or pay-per-view services to be delivered. As long as the reserved PIDs are not used, the packets of data associated with future, currently undefined applications, would be ignored by the initial generation of DTV receivers. Packets that conform to the ATSC DTV Standard but not used to transmit DTV programs, can be employed for any other services that can be distributed by digital data. The use of these packets should be coordinated within the affected industries, so that conflicting uses do not develop. They can be received by a special-purpose decoder or, if specific services become popular, voluntary industry standards may be adopted and decoders may be built into some or all DTV receivers.

20. Extensibility. In the future, new services may be uniquely identified through the use of new PIDs that would be ignored by previously deployed digital receivers. Such data could be used to augment DTV programs in some fashion (such as allowing migration to a 1080-line progressive scan format) or could permit new services that have not yet been envisioned. Either extension of the DTV service would require new DTV receivers or new decoder devices to be developed and used in order to obtain the benefits of the new service or functionality, but would not disrupt provision of DTV service to consumers using existing sets. The marketplace would determine the extent to which sets with new functionalities are available.

IV. Adopting the ATSC DTV Standard.

21. Having described the components of the ATSC DTV Standard, we next turn to a discussion of our approach to standards in the context of digital television. There is near universal agreement that transmission standards, either de facto or de jure, confer many benefits.[11] We believe that the proposals discussed herein would enable consumers, licensees and equipment manufacturers to realize the benefits of standards without unduly restricting innovation and competition.

22. Previous Statements. Previously, we have asked whether mandatory transmission standards serve the public interest. In our initial 1987 Notice of Inquiry in this proceeding, we noted that NTSC standards were established during the television industry's infancy when universal compatibility standards were arguably necessary in order to develop a national television broadcasting system in a timely manner.[12] A standard, we stated, would assure that "[a] receiver manufacturer could design his product to display an image from the standard NTSC signal with the knowledge that his receiver would function with any television broadcast transmitter."[13] However, we also stated that the continuation of mandatory standards may no longer be necessary and may even be counterproductive.[14] We indicated that it appeared that there would be no adverse effects on the delivery of broadcast television if the NTSC standard were made voluntary, allowing for the accommodation of enhancements to television signals. With regard to the desirability of encouraging compatibility among the several advanced television transmission systems that were then in various stages of planning or development,[15] we stated that, although there might be "substantial benefits to consumers if ATV compatibility standards are adopted, either through formal Commission action or through voluntary standards organizations," we also noted the benefits "that could come about through improvements in technology made subsequent to the establishment of standards, and we do not wish to foreclose these possibilities."[16] In the First Inquiry, we listed three different ways of achieving compatibility while not precluding the introduction of future technological improvements. We stated that we could: 1) adopt, as voluntary guidelines, the results of an industry consensus; 2) establish detailed compatibility criteria that would be applicable only for a short period of time; or 3) if the systems prove adaptable to this approach, protect a key frequency component of the modulated baseband in much the same

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[11] For a discussion of the benefits of standards, see Stanley M. Besen and Leland L. Johnson, Compatibility Standards, Competition, and Innovation in the Broadcast Industry (Santa Monica, CA: The RAND Corporation, 1986) at 7-9.

[12] First Inquiry, supra at 5135.

[13] Id.

[14] Id.

[15] Id. at 5125.

[16] Id. at 5136

way we did for multi-channel television sound.[17]

23. In the 1988 Second Inquiry, we continued our examination of whether the NTSC standard should be relaxed or repealed, how standards should be established for advanced television, and whether it would be desirable to require compatibility between advanced television broadcast transmissions and other ATV distribution media.[18] We also stated that, although it was then premature to adopt an advanced television standard, "we believe that the public interest compels a Commission role in the development of standards with the advice and involvement of all sectors of the industry."[19] In this regard, we asserted that establishing a standard has certain advantages such as pointing the various interested parties in the same direction, reducing the risk to both audiences and broadcasters of investments in systems that might become obsolete if a different system is introduced in the market, and overcoming reluctance to invest in new equipment.[20]

24. We also stated that, "detailed, inflexible standards that have the force of law may reduce consumer choice and prevent the timely introduction of new technology."[21] To encourage future improvement of ATV systems and the development of newer and technically superior ATV systems, we stated that we could: (1) protect a standard by prohibiting interference to systems using that standard; (2) adopt a standard for allocation and assignment purposes only; or (3) adopt a sunset provision making adherence to the standard optional after an established period.

25. In response to our previous request for comments on adopting an ATV standard we received some 50 comments, 23 reply comments and two supplemental reply comments. Most commenting parties supported the adoption of a single, mandatory terrestrial broadcast advanced television standard.[22] They generally believed that such action would result in the most rapid development and acceptance of advanced television equipment, particularly in the consumer marketplace, by promoting cost-effective receiver designs, thereby providing the largest audience for initial broadcasts of advanced television programming. Some

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[17] Id.

[18] Tentative Decision and Further Notice of Inquiry in MM Docket No. 87-268 ("Second Inquiry"), 3 FCC Rcd 6520, 6534 (1988).

[19] Id.

[20] Id. at 6534-35.

[21] Id. at 6535.

[22] These commenters included MSTV (then MST), CBS, Cap Cities, NBC, CPB, PBS, NAB, Joint Broadcast Commenters, Group W., IEEE, TRAC, Sarnoff, NYIT, EIT, PacTel, Zenith, Philips, and the Tribune Company, in reply comments

commenters, however, including the Federal Trade Commission and GTE, questioned whether it is in the public interest to adopt a single mandatory standard, as doing so, they believed, could have the result of denying users better technology and services or running the risk of selection of the wrong standard. As to the issue of whether the Commission should adopt a complete standard, as opposed to adopting a standard for limited purposes such as protection from interference or for channel allocation and assignment, commenting parties favored the adoption of a complete standard.[23] Finally, parties addressing the issue of adoption of a standard for a limited duration were uniformly in opposition.[24] They argued that a "flexible" standard that can accommodate future technological improvements would be more appropriate. Equipment manufacturers opposed a standard of limited duration because, they stated, it would leave the future unpredictable and would send a strong signal that broadcast and receiving equipment designed to that standard would become obsolete. Not withstanding these comments, we believe that recent developments warrant revisiting these issues.

26. Subsequent to our statements concerning standards in the 1987 and 1988 decisions, as described above, we concluded in 1990 that "[c]onsistent with our goal of ensuring excellence in ATV service, we intend to select a simulcast high definition television system."[25] We also stated that, "parties filing comments in response to the *Further Notice* generally assume that the Commission will ultimately authorize a system using new technology that will provide HDTV service." (Footnote omitted.)[26] The Commission's November 14, 1990 Memorandum of Understanding with the Advisory Committee, the Advanced Television Test Center, Inc., Cable Television Laboratories, Inc., and the Canadian Communications Research Centre said, "[t]he FCC's stated intention is to select an ATV standard by the second quarter of 1993."

27. Recent Developments. Two developments since the Commission addressed these issues are relevant to whether and, if so, what form of a required standard is desirable. First, the presence of a single consensus standard, in contrast to the multiple competing systems vying for approval in 1990, arguably changes the balance of considerations. The

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[23] Commenters opposing adoption of a standard for only limited purposes included, CPB, NAB, Joint Broadcast Commenters, EIA, NBC, Philips and Zenith. Zenith, for example, maintained that adopting a recommended standard would be indecisive, encourage other alternatives, and would not further the introduction or acceptance of new technology. NAB stated that it would not matter whether the Commission "protects" or mandates a particular transmission standard; it asserted that adopting a standard merely as a planning parameter for allocation purposes would not assure continued compatibility.

[24] The parties addressing this issue were NAB, Sarnoff, EIA, NBC, Phillips, and Sony.

[25] First Report and Order, 5 FCC Rcd 5626, 5628 (1990).

[26] Id.

presence of multiple competing systems strengthened the argument for selecting a standard. Today, only one system has been recommended by our Advisory Committee and no other competing technology appears to demonstrate superiority over the ATSC DTV Standard.[27] Thus, to the extent that concerns with the possibility of multiple competing systems were decisive in our earlier decisions, they may be less relevant today.

28. Second, the capabilities of digital transmission technologies represent a major change in circumstances since this proceeding began. The original focus of this proceeding was the initiation of "advanced television service" to provide improved video and audio quality.[28] Prior to the development of the ATSC DTV Standard, it was widely believed that the service offered by a licensee would change from one NTSC program stream to one HDTV program stream. Today's digital technologies and improved compression techniques create the opportunity for delivering one, and under special circumstances perhaps two, HDTV program streams, or multiple program streams at lower resolution. Furthermore, digital technologies give each licensee the technical capacity to explore new business opportunities and provide new services. If some licensees believe that they can compete better by offering a unique set of services to consumers, the differences between one licensee and another may be much greater than exists today where each and every licensee offers one NTSC program stream. The opportunity for each licensee to offer a unique set of services is something that seemed only a distant possibility when we began this proceeding, now the ATSC DTV Standard makes it a reality. If the ATSC DTV Standard is as dynamic as believed, a required standard will not thwart technical advance. Nevertheless, the inherently unforeseeable nature of innovation makes it impossible to predict the extent to which a required standard might affect future technological advances.

29. The Role of the Commission in Setting Standards. While there is near universal agreement on the benefits of standards, we solicit comment specifically on whether requiring the use of the ATSC DTV Standard by digital television licensees is the best approach for realizing these benefits. Critics of compulsory standards cite the cost of potentially freezing the state of the art, erecting barriers to technological innovation, and limiting competition in the television equipment manufacturing business.[29] However, in some situations the benefits of standards may not be fully realized in the absence of a requirement. We seek a complete record that will allow us to choose a course that accomplishes our goals of providing consumer benefits, certainty and a smooth introduction of digital television while encouraging innovation and promoting competition.

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[27] ACATS Report at 17.

[28] Second Inquiry, supra at 6521.

[29] See Jeffrey Krauss, "Implications of FCC Regulation of Telecommunications Technical Standards," IEEE Communications Magazine 20 (September 1982): 28-32; Joseph Farrell and Carl Shapiro, "Standard Setting in High-Definition Television," Brookings Papers: Microeconomics (1992): 1-93.

30. The Commission has been involved in the development of standards throughout this proceeding. We decided that DTV would be offered on frequencies currently allocated to television broadcasting and the DTV signal would be carried on a 6 MHz channel. We continue to support these conclusions. While these actions guided the development of DTV systems, establishing an Advisory Committee may have been our most important action. Besen and Johnson assert that the most constructive role a government agency can play in the standard-setting process is to ratify standards agreed upon through private action when differences among alternatives are small.[30] The government role in this case up to this point has been primarily to provide a rallying point for purposes of coordination. We believe that the Commission's Advisory Committee has successfully fulfilled this role. Throughout this proceeding, the Advisory Committee has served as a catalyst for focusing and coordinating the efforts of private industry. In addition, the Advisory Committee has provided a forum for addressing and responding to the concerns of a wide array of interests.

31. Analysis of Required Standards. The traditional rationale for requiring a standard arises when two conditions are met.[31] First, that there is a substantial public benefit from a standard. Second, private industry either will not, or cannot, produce a standard because the private costs of getting involved in standard setting outweigh the private benefits, or a number of different standards have been developed and private industry cannot agree which should become the standard. The second condition may not be applicable in view of the strong industry coalescence around the ATSC DTV Standard. However, we believe that the first condition applies to DTV. Television today is a ubiquitous service that is available to almost every American household and is relied on by a majority of Americans as their primary news and information source.[32]

32. A required standard may provide additional certainty to consumers, licensees, and equipment manufacturers, especially during the launch of this new technology. A required standard may protect consumers against losses by assuring them that their investments in DTV equipment will not be made obsolete by a different technology. In addition, requiring use of a single standard guarantees compatibility. This assures consumers that the DTV equipment they purchase to view one television station can be used to view every other

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[30] Stanley M. Besen and Leland L. Johnson, Compatibility Standards, Competition, and Innovation in the Broadcast Industry (Santa Monica, CA: The RAND Corporation, 1986) at 134.

[31] Stanley M. Besen and Garth Saloner, "The Economics of Telecommunications Standards," in Changing the Rules: Technological Change, International Competition, and Regulation in Communications, Robert W. Crandall and Kenneth Flamm, editors (The Brookings Institute, 1989)

[32] Seventy-two percent of Americans rely on television as their primary source of news. NTVA, Roper-Starch, NAB, America's Watching - Public Attitudes Toward Television-1995, at 17.

television station. The compatibility guaranteed by a single required standard may also reduce consumer costs by eliminating the need to purchase duplicative equipment or special devices to convert from one standard to another. Finally, a required standard may lead to a more rapid development and acceptance of DTV equipment. Absent a required standard, some consumers and licensees may be reluctant to purchase DTV equipment if they believe that different DTV technologies may become available in the near future. A required standard may reduce such "wait and see" behavior

33. Although there are benefits to required standards, there also may be certain costs. One may be deterrence of technical innovations.[33] Digital broadcasting technology is in its infancy and further advances are likely to occur. An unexpected turning point in the approach to advanced television has occurred once in the development process with the demonstration of the viability of an all-digital system. Recognizing the novelty and fluidity of the technology, we must determine how any specific approach to standards might impede further advances.

34. Over time, we expect that normal technological progress will lead to improvements. If subsequent technological improvements cannot be readily incorporated into the ATSC DTV Standard, the Standard could lock the broadcast market into less than optimal technology. The NTSC standard adopted in 1941 was subsequently improved in 1953 with the approval of the NTSC color standard. While picture quality has steadily improved, nevertheless the ACATS Report states "[o]nly a few minor improvements (most notably, the addition of stereo audio in 1986) have been made in the ensuing four decades."[34]

35. Required standards also may reduce some forms of competition while enhancing others. With required standards, equipment manufacturers cannot compete by offering differentiated products using different technologies. Required standards preclude this form of competition. As such, a primary cost of required standards is loss of variety.[35] On the other hand, required standards, which are licensed to everyone on a non-discriminatory basis, may intensify the more conventional forms of competition, such as price, service, and product

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[33] For an overview of the characteristics of the television broadcast market that contribute to the inertia of established standards see Bruce M. Owen and Steven S. Wildman. Video Economics, (Harvard University Press, 1992): 260-313. For a more general discussion of the characteristics of one-way and two-way communications systems that affect the adoption of technology see Michael L. Katz and Carl Shapiro, "Systems Competition and Network Effects," Journal of Economic Perspectives (Spring 1994): 93-115.

[34] ACATS Report at 1.

[35] Katz and Shapiro, supra at 110.

features.[36]

36. As we weigh the benefits and costs of required standards, we note that for MMDS and new services like PCS, DBS, and DARS, we have decided to allow the marketplace to determine transmission standards. In the infancy of cellular telephony we mandated transmission standards for analog devices. But when the cellular telephony industry became more mature, we declined to mandate transmission standards for advanced digital cellular telephony devices. We recognize that these decisions were made in a context different from that of terrestrial broadcast television. Unlike the case with PCS, DBS, and DARS, broadcast television is an established industry upon which the American people rely for both information and entertainment. Additionally, unlike these other services, free over-the-air broadcast television is a mass market media serving nearly all of the American public nationwide rather than a subscription service in which the service provider may supply the reception equipment.[37] In this context, the goals of certainty and reliability take on a different significance than may have been present with respect to other communications services and strengthens the case for our adoption of a DTV standard. We invite commenters to discuss how the rationale that in the past led us to require television broadcast transmission standards applies as we launch DTV. Are there other unique characteristics (such as the ubiquitous nature of TV and the reliance Americans place on it as an information source), or public policy goals (such as the swift transition to regain spectrum and reduce costs) which distinguish television broadcasting such that mandating a standard is essential to the provision of the service?

37. Proposal. We propose to adopt the ATSC DTV Standard. Specifically, we propose to require the use by digital television licensees of each element of the ATSC DTV Standard. The ATSC DTV Standard describes a remarkably capable and flexible system, one that exceeds the Commission's expectations when it began this proceeding in 1987, and that appears to have widespread support. We tentatively conclude that requiring the use of the ATSC DTV Standard is appropriate because it would provide a measure of certainty and confidence to manufacturers, broadcasters and consumers, thus helping assure a smooth implementation of digital broadcast television and the preservation of a free and universally available broadcast television service.

38. The digital television system that has been recommended by the Advisory Committee appears to be dynamic, flexible and high quality. It provides a variety of picture formats that will allow broadcasters to select the one most appropriate for their program

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[36] Stanley M. Besen and Joseph Farrell, "Choosing How to Compete: Strategies and Tactics in Standardization, Journal of Economic Perspectives (Spring 1994): 117-131.

[37] America's Watching - Public Attitudes Toward Television-1995, supra, at p. 3. Even nearly 60% of viewing in cable television households is of the programming of broadcast television stations. NCTA, Cable Television Developments, Fall 1995, at 5.

material, ranging from very high resolution providing the best possible picture quality to multiple programs of lower resolution, which could result in increased choices for viewers. Even at the lower resolutions, the recommended system represents a clear improvement over the current NTSC standard.

39. Use of the ATSC DTV Standard also represents a rare opportunity to increase significantly the efficient use of broadcast spectrum. The ATSC DTV Standard will allow channels unusable in the NTSC analog environment to be assigned for digital broadcasting between existing NTSC channels. It was designed to be flexible enough to incorporate future improvements, including those resulting in ever higher resolution, that the Advisory Committee believes will be made possible by future advances in compression and display technology.

40. We believe that the "headroom" for innovation incorporated in the ATSC DTV Standard, along with the desirability of providing certainty and confidence, argue in favor of a required standard. In addition, the flexibility of the ATSC DTV Standard significantly reduces some of the potential detriments associated with a required standard as the new technology is being launched. The packetized structure of the data transport, as described above, ensures a flexibility that will permit the DTV licensee to provide, for instance, several standard definition programs, or one high-definition program, or some standard definition programming together with data transfer or electronic publishing on the remaining bit streams, and to switch instantaneously between such applications. Other applications are limited primarily by the imagination of the DTV licensee. This means that a wide array of innovations can be introduced without Commission action.

41. We seek comment on the tentative conclusion that we will require use of the ATSC DTV Standard. Assuming that we do require the use of the ATSC DTV Standard by digital television licensees, we request comment on whether we should place the Standard into our rules in its entirety or whether we should incorporate it by reference.[38]

42. While we propose to require digital television licensees to use the ATSC DTV Standard, we recognize that the benefits of a required standard may become attenuated over time, as the costs of a requirement may increase. At some point, when the new digital broadcasting technology has become firmly established, requirements designed to promote certainty and to foster a smooth implementation of digital television may no longer be necessary. Meanwhile, over time, the likelihood increases that there will be technological

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[38] See Letter dated April 2, 1996, submitted for the record by Joseph P. Markoski of the law firm of Squire, Sanders & Dempsey on behalf of the EIA and the EIA Advanced Television Committee. The letter cites as precedent for incorporating the standard into our Rules by reference Sections 73.682(a)(14), 73.682(a)(21)(iv) and 15.31(a)(6) of the Commission's Rules. A similar but alternative, proposal would be to publish the Standard not in our Rules but, rather, as an OET technical bulletin.

innovation that even the flexible ATSC DTV Standard may not be able to accommodate. In addition, given the pace of technological change, it is likely that there will be unforeseeable innovations that are incompatible with the ATSC DTV Standard. As long as there is a requirement in our rules that DTV licensees use only the ATSC DTV Standard, such innovations could not be introduced to consumers without a potentially costly and time-consuming Commission proceeding. That, in turn, could reduce the incentive to conduct the research and development that leads to innovation.

43. In addition to ensuring that the Commission's rules promote the rapid introduction of digital television broadcasting, we seek in this proceeding to adopt rules that encourage further innovation by those who have devised the ATSC DTV Standard as well as new entrants. We also seek to minimize our regulations and to have the regulations that we do adopt remain in effect no longer than necessary. We are mindful, finally, of the spirit of the recently adopted Telecommunications Act of 1996, which seeks, "[t]o promote competition and reduce regulation in order to secure lower prices and higher quality services for American telecommunications consumers and encourage the rapid deployment of new telecommunications technologies."[39]

44. There are several options that arguably could accomplish these goals and we propose to adopt one, or more than one in combination.[40] The Commission could proceed under its current processes for regulatory evolution and change, which include consideration, as appropriate, of requests from parties to amend its rules and reviews initiated by the agency. Such requests often follow substantial changes in technologies or services when the Commission, industry or other members of the public believe change is warranted.

45. Alternatively, the Commission could commit itself to conduct a proceeding to review the Standard at some future time. If the Commission chooses this option, should a review be structured to place the burden of persuasion on those seeking to continue requiring a standard or on those seeking to eliminate the requirement? When should such a review take place? Should we select a specific date or should we link the review to an objective event?

46. Finally, the Commission could establish a period of time after which the ATSC DTV Standard no longer would be required or exclusive. At the conclusion of some meaningful period of time, digital licensees would be free to use any technology that does not interfere with users of the ATSC DTV Standard. If such a sunset provision were to be adopted, how should we determine when the mandatory aspects of our rules would expire?

47. Commenters are encouraged to comment on the foregoing and to propose other

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[39] Preamble to Pub. L. No. 104-104, 110 Stat. 56 (1996).

[40] These options are not necessarily incompatible. For example, we could adopt a sunset provision but also provide for Commission review of the Standard prior to the sunset.

options. In so doing, they should provide a thorough explanation of the benefits and detriments of their options and an explanation of how their options serve the goals that we have outlined above.

48. Finally, we seek comment on alternative approaches to requiring a standard, including those the Commission has previously identified: (1) authorizing use of a standard and prohibiting interference to it, but not requiring the use of that standard;[41] and (2) adopting a standard for allocation and assignment purposes only.[42] We also seek comment on requiring use of some layers of the ATSC DTV Standard (described more fully above) but making others optional. For example, would it be desirable to require digital licensees to use the RF/transmission layer of the ATSC DTV Standard, while leaving them free to choose coding and compression technologies different from those described in the ATSC DTV Standard?

49. Acceptability of the ATSC DTV Standard. The ATSC DTV Standard describes a remarkable system that is capable and flexible well beyond the expectations of a few short years ago. It is the product of the genius and persistence of its creators and is a tribute to their efforts. Although the ATSC DTV Standard has many supporters, it also has its critics. Segments of both the computer industry and the entertainment industry have leveled criticisms at the Standard. Some in the computer industry argue that the presence of interlaced scanning formats, the 60 Hz transmission rate, aspect ratios, colorimetry and non-square pixel spacing in the ATSC DTV Standard all merit further consideration.[43] Apple, for instance, asks that the ATSC DTV Standard be modified so that "ATV does not employ interlaced transmission; the refresh rate allows rates greater than 70 images/second; improved standards of data integrity are incorporated; and the data elements be displayed at equal distances, both horizontally and vertically ("square pixels")." In addition it requests that the aspect ratio be reconsidered.

50. Proponents of the ATSC DTV Standard respond that the Standard was developed for terrestrial broadcasting but has incorporated significant elements to enhance compatibility with computers.[44] With respect to the issue of the presence of interlaced scanning in the proposed Standard, the Grand Alliance argues that " the Grand Alliance HDTV system

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[41] Second Inquiry, supra at 6535.

[42] Id.

[43] See Comments of Apple Computer, Inc., and Microsoft Corporation, in response to the Fourth Further Notice of Proposed Rule Making and Third Notice of Inquiry in MM Docket No. 87-268 ("Fourth Further Notice"), 10 FCC Rcd 10540 (1995).

[44] Letter of Stanley Baron, President, Society of Motion Picture and Television Engineers ("SMPTE"), 28 August 1995, at 2; Memo of Paul Misener, ACATS, to Fiona Branton, ITI ("Misener Memo"), August 18, 1995, at 1-2. Reply Comments of the Digital HDTV Grand Alliance in response to the Fourth Further Notice at 38 and 40.

emphasizes progressive scan -- five of the six HDTV formats are progressive scan, and the Advisory Committee believes that the lone interlaced format should be "migrated" to progressive as soon as improvements in digital compression and transmission technology make an over-1000 line, 60 Hz progressively scanned format achievable within a 6 MHz terrestrial channel."[45] Proponents assert that computer displays are also available with a wide variety of refresh rates, including 60 Hz, and assert that "[i]n computers, where there is no standard for display format or frame rate, it is the responsibility of software to determine the method of conversion between source and display frame rates."[46] Moreover, they indicate that receiver manufacturers are free to provide any display rate or rates that they desire.[47] Finally, proponents assert that problems with data integrity stem from bit error rates inherent in the broadcast environment, not from the system design.[48] They state that error free data transmission is not guaranteed by any transmission system, citing in particular telephone modems used extensively for computer communications.[49]

51. There also has been objection from cinematographers to the 16:9 aspect ratio contained in the ATSC DTV Standard. They are concerned that the proposed Standard may limit broadcasters' ability to display the full artistic quality of their work. The American Society of Cinematographers has expressed the belief that the 16:9 ratio would leave digital television unable "to properly display a large portion of the largest existing library of programming."[50] It suggests, instead, that HDTV be displayed in a 2:1 aspect ratio. That standard "would allow previous material to be faithfully displayed in its original aspect ratio with insignificant letterboxing" and is attractive to cinematographers for future feature and High Definition production.[51]

52. In reply, the Society of Motion Picture and Television Engineers (SMPTE) states that the 16:9 aspect ratio was established by the SMPTE Working Group on High Definition Electronic Production in 1985 on the basis of studies of the requirement for both motion picture and television production. All meetings of the group, SMPTE notes, were open and

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[45] Reply Comments of the HDTV Grand Alliance, supra at 40.

[46] Letter of Stanley Baron, President, SMPTE, 28 August 1995, at 4.

[47] Id. at 5. In this regard, the Grand Alliance asserts that transmission and display formats are not linked and need not be the same. Reply Comments of the HDTV Grand Alliance, supra at 40.

[48] Misener Memo at 5.

[49] Misener Memo at 6.

[50] Statement of the American Society of Cinematographers on HDTV Aspect Ratio.

[51] Id.

well publicized.[52] Moreover, it states that the value of 16:9 for aspect ratio was decided upon only after long debate and that "due consideration was given to the then current practices both in North America and around the world."[53] That aspect ratio, it continues, has been adopted internationally in the International Telecommunications Union for HDTV and for EDTV in Europe and Japan.[54] SMPTE states that it has been demonstrated that there is no difficulty in accommodating program material or motion picture films of any reasonable aspect ratio within the 16:9 format either for production and post-production, distribution or display.[55] Material originally composed for a 2:1 aspect ratio, it continues, could be accommodated by leaving 11% of the vertical space unused.

53. Additionally, we note that low power television station ("LPTV") operators generally want to be included in the implementation of digital technology, and have suggested that, if LPTV is excluded, its continued viability would be jeopardized. LPTV commenters in the past rounds of the digital TV proceeding have focused their comments primarily on issues such as DTV eligibility, channel allotments and interference criteria, issues perceived to affect the continued existence of their stations rather than upon the ATSC DTV Standard itself. Nevertheless, the LPTV industry is concerned that any standards that could adversely affect their operations be thoroughly documented in this proceeding.[56]

54. We seek comment on these issues. However, note that the ATSC DTV Standard was arrived at only after years of thoughtful consideration and expert research and development in an open process in which all interests were able to participate. Accordingly, we believe that those opposing our mandate of the ATSC DTV Standard should have the burden of persuasion as to why that standard should not be adopted.

V. Protection from Interference.

55. Protection from interference is a fundamental Commission function that must be considered when introducing new technologies into spectrum allocations currently in use. In this situation, we are, in effect, considering sharing criteria to govern the technical interaction

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[52] Letter of Stanley Baron, President, Society of Motion Picture and Television Engineers, 18 August 1995, at 1-2.

[53] Id. at 2.

[54] Id.

[55] Id. at 3. In this regard it notes that there is a broad range of aspect ratios that has been employed in modern times and that there is no single aspect ratio that is usable universally.

[56] See, e.g., Comments of Abacus Television in response to the Fourth Further Notice, at 24-25.

between the old and new technologies. Many of these criteria will be considered in the near future, when we propose an initial Table of DTV Allotments and technical criteria for amending that Table with additional DTV allotments in the future.[57] We expect that the DTV allotments and allotment criteria will be based on the ATSC DTV Standard and the performance of the DTV system it describes, as determined by the extensive ACATS measurement program. In addition to criteria we will propose then, there are some interference-related aspects of the ATSC DTV Standard that we shall explore now. In the following paragraphs, we solicit comment on limitations on stations using the ATSC DTV Standard that might be needed to avoid objectionable interference to reception of either existing NTSC service or the reception of other stations that use the ATSC DTV Standard.

56. Aside from the technical parameters that directly affect the development of a DTV allotment plan, several related considerations affect whether stations operating in accordance with the ATSC DTV Standard cause more interference than predicted based on the system performance measurements. First, we propose to adopt an emission mask, limiting the out-of-channel emissions from a DTV station transmitter, measured after any external filter that may be used and based on a measurement bandwidth of 500 kHz. We seek comment on the following emission mask: (A) at the channel edge, emissions attenuated no less than 35 dB below the average transmitted power; (B) more than 6 MHz from the channel edge, emissions attenuated no less than 60 dB below the average transmitted power; and (C) at any frequency between 0 and 6 MHz from the channel edge, emissions attenuated no less than the value determined using the following formula:

Attenuation in dB = 35 + [$(\Delta f)^2$/1 44]

Where: Δf = frequency difference in MHz from the edge of the channel

This proposal is derived from analysis of the ACATS test results for protection of adjacent channel stations. The attenuation level is based on an assumption that the average DTV power in a 6 MHz channel is 12 dB less than the NTSC station effective radiated power (ERP). This power difference provides approximately equal noise limited coverage for DTV and NTSC stations in the UHF frequency band. If DTV stations are permitted to operate in a co-located adjacent channel arrangement with average DTV power exceeding that assumed value (12 dB below the co-located NTSC station's ERP), greater attenuation of the out-of-band emissions may be required.[58]

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[57] We anticipate that in making such a proposal, we also would seek comment on a permitted DTV power for each allotment, a definition of service area and interference desired-to-undesired ratios developed from the ACATS work and data.

[58] In recent years, the Global Positioning System (GPS), which uses the frequency band at 1575.42 +/-10 MHz, has come into increased use. It is being considered as a replacement for Instrument Landing Systems for aircraft navigation during landings. We are aware of

57. Second, ACATS has reported interference from an upper-adjacent channel DTV signal to reception of an NTSC station that is related to the precise location of the DTV signal pilot carrier frequency.[59] To prevent interference to NTSC receivers from this source, we are proposing to require an ATSC DTV Standard station pilot frequency to be located 5.082138 MHz above the visual carrier of the lower adjacent channel NTSC station. The above stated frequency difference between the NTSC visual carrier and the DTV VSB pilot would need to be maintained within a tolerance of +/- 3 Hz.[60]

58. Third, we propose to specify the maximum power for each DTV station as an average power across the occupied bandwidth, so an appropriate method or methods of determining operating power will be different from the established NTSC procedures, which determine the power transmitted during each synchronizing pulse (peak power). We propose that stations using the ATSC DTV Standard would be allowed to determine their average power using conventional RMS averaging power meters. While that would be the official method for determining compliance with the authorized power limits, we propose that such stations would be allowed to decide how they would remain in compliance with their power limits. We seek comment on all of the foregoing including whether the proposed limits on out-of-channel emissions, pilot carrier frequency tolerance and average power determination are appropriate and represent the minimum necessary requirements for controlling the interference potential of stations operating in conformance with the ATSC DTV standard. We also seek comment on whether the proposed limits are sufficient for this purpose, or if other parameters also need to be constrained.

59. In addition to rules restricting broadcast stations that relate to interference concerns, there are many rules that establish procedures or have been applied broadly to all broadcast stations. We propose to modify many of them to include DTV, or to adapt them

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concern about interference that might be caused by insufficient suppression of spurious emissions from TV stations (including DTV and mainly focusing on UHF TV channels 23 and 66, because GPS operates at a harmonic frequency of these channels) and we seek comments.

[59] ACATS Final Technical Report at 5.2.8. "With regard to upper adjacent-channel video interference ATV-into-NTSC, the tests found a 'color stripe' artifact in the NTSC video at all NTSC power levels. Analysis shows that it is caused by the ATV pilot carrier frequency 'beating' with the NTSC color subcarrier. Analysis also suggests that another 'luminance beat,' hidden during the testing by the color beat, would be present, caused by the ATV pilot carrier beating with the NTSC visual carrier. Finally, during these tests, some NTSC receivers showed loss of color and other picture artifacts. The analysis shows that use of precision carrier offset between the ATV pilot and the NTSC color subcarrier will eliminate visibility of both artifacts."

[60] See Annex to ACATS Report, Record of Test Results for Digital HDTV Grand Alliance System, (October 1995), at I-14-67.

and create new DTV rules, as appropriate so that eligible licensees might move quickly to introduce this new technology to consumers. A preliminary list of these technical and procedural rules is attached as Appendix A. We seek comment on whether they should be modified to include DTV, be changed to treat DTV differently than NTSC or other broadcast services are treated, or if they need not be applied to DTV. Commenters addressing this issue should provide specific recommendations, rule-by-rule, as to the modifications they advocate.

VI. Interoperability

60. Cross-Industry Interoperability. Compatibility with other transmission forms and media applications has been an important issue throughout this proceeding. Since its inception, ACATS emphasized the need for DTV broadcasting technology to be interoperable with alternative media.[61] In addition, ACATS has recognized that interoperability takes on critical importance given the future needs for high resolution digital imagery and the development of a National Information Infrastructure. ACATS believes that the ATSC DTV Standard is suitably interoperable with other video delivery media and imaging systems, including cable television, direct broadcast satellite, and computer systems. A working party tasked to study interoperability developed recommendations that led to agreement on so-called "headers and descriptors." This method of data identification, combined with advanced data packetization techniques, acts as a kind of translator to tell all digital devices what type of data is being transmitted.

61. The working party and an "interoperability review panel" also adopted a list of eleven characteristics critical to interoperability based on the needs and desires exhibited by alternative media advocates.[62] ACATS believes the Grand Alliance video system adequately addresses all eleven factors. For example, compliance with the MPEG-2 standard was emphasized by the Technical Subgroup and adopted by the Grand Alliance to increase international compatibility and, more importantly, interoperability among a variety of digital devices. In addition, progressive scanning and square pixels were included because these attributes are preferable for some -- particularly computer -- applications. As noted earlier, some advocates feel that the ATSC DTV Standard should go further, especially with regard to the exclusive use of progressive scanning.[63]

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[61] This description of the ACATS position on interoperability is largely derived from the ACATS Report at 15-16.

[62] ACATS Report, Appendix I.

[63] See, Comments of Apple Computer, Inc. (in response to the Fourth Further Notice) at 4-7; see also Testimony of Joseph Tasker on behalf of the Computer Industry Coalition on Advanced Television Service at the Commission's December 12, 1995, en banc hearings on digital television.

62. In all, ACATS believes that the Grand Alliance plan strikes the best balance between various technical considerations and needs of different industries. It is a balance that has been endorsed by, among others, a subgroup of the Federal Government's Information Infrastructure Task Force, the 1994 NIST/ARPA Workshop on Advanced Digital Video, and the Information Technology Industry Council ("ITI").[64] We request comment on the level of interoperability between the ATSC DTV Standard and alternative media and on the ACATS Report's conclusion that it is adequate. Are there any critical interoperability problems that remain? What additional actions, if any, might the Commission take to facilitate interoperability? We ask that in commenting on this issue, commenters provide specific technical or economic analyses upon which we can make our decision.

63. With digital technologies, differences in transmission methods could develop between broadcast and alternative media if an appropriate variant of the ATSC DTV Standard is not required for alternative media. There is no guarantee that alternative media will choose the ATSC DTV Standard. Alternative media may choose different technologies to take advantage of differences in bandwidth or in the conditions encountered in the transmission path. In addition, some companies may wish to make use of proprietary systems that are not compatible with other companies or alternative media. In our Second Inquiry, we expressed "our tentative view that ATV compatibility among alternative media also may develop in an appropriate manner without government involvement."[65] While we recognized that there may be benefits to compatibility, we added that "we do not intend to retard the introduction of ATV on non-broadcast media, nor do we intend at this point to require compatibility among the various media or set specific signal or equipment standards for this purpose."[66] We seek comment on whether this view remains correct.

64. In the Cable Television Consumer Protection and Competition Act of 1992 (1992 Cable Act), Congress expressed concern about compatibility between consumer electronics equipment and cable systems.[67] We are aware of concern within the broadcast industry that,

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[64] ACATS Report at 16. See also Information Technology Industry Council, "Position Statement on Standards for Advanced Television," October 31, 1995, at 1-2. We note that subsequently ITI stated that the ATSC DTV Standard "will be an important part of a diverse and flexible NII" and "urges the Commission to promptly adopt and implement" it, but without the interlace options, stating that it believes "a truly interoperable ATV system will require the exclusive use of progressive scan." See Comments of the Industry Information Technology Industry Council filed in response to the Fourth Further Notice, at 2-3.

[65] Second Inquiry, supra at 6537.

[66] Id.

[67] See Cable Television Consumer Protection and Competition Act of 1992, Pub. L. No. 102-385, 106 Stat. 1460, (1992). Section 17 of the 1992 Cable Act added a new Section 624A to the Communications Act of 1934, which has been implemented by First Report and

for example, cable systems may voluntarily adopt QAM modulation in lieu of VSB modulation specified in the ATSC DTV Standard Some cable system operators suggest deploying a DTV system that does not use B-frames. B-frames necessarily call for more memory to be installed in the receiver or set-top converter, slightly raising costs. While essential for providing the highest quality compressed video, there is a debate within the cable industry as to the need for B-frames when the service provider seeks to reduce costs at the receiver (or set-top convertor) to a minimum. This economy may come at the expense of video quality or compatibility with a broadcast stream which complies with the ATSC DTV Standard. While we understand that such technical distinctions between broadcast and cable may at some extreme cause consumer harm, we also recognize that it is in the economic interests of the providers to ensure consumers have access to the most desirable programming. Today, nearly 60 percent of cable viewing hours are spent watching broadcast programming, much of which is provided under retransmission consent agreements.[68] In light of these concerns, we seek comment on whether the public interest would be served by Commission involvement to assure compatibility between digital broadcast standards and digital cable standards. Similarly, there would appear to be advantages and disadvantages to Commission involvement to assure compatibility between other existing and potential competing video delivery methods, including DBS, MMDS, Instructional Television Fixed Service ("ITFS") and open video systems. We seek comment on the considerations that apply in these different environments.

VII. Other Issues.

65. Receiver Standards and Related Features. In the Fourth Further Notice, we stated that it was our understanding that companies were working on receiver designs that would display HDTV signals as lower resolution pictures, sometimes called "standard definition" or SDTV, and that such a conversion would result in relatively inexpensive digital television receivers or converter boxes for NTSC receivers, as compared to projected HDTV receiver costs.[69] Accordingly, we solicited comment on whether DTV receivers should be required to have the ability to receive both SDTV and HDTV transmissions, whether we should regulate how such signals should be displayed and whether permitting the manufacture only of "all format" receivers capable of displaying NTSC, SDTV and HDTV signals would be consistent with the All-Channel Receiver Act or otherwise in the public interest.[70]

Order in ET Docket No. 93-7, 9 FCC Rcd 1981 (1994). Section 301 of the Telecom Act, in turn, has modified Section 624A.

[68] In the 1993/1994 television season, almost 60 percent of all television viewing in cable TV homes was of broadcast television stations. NCTA, Cable Television Developments, Fall 1995, at 5.

[69] Fourth Further Notice, supra at 10552

[70] Id. at 10552